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ORIGINAL PAPER

From peat bog to lignite seam: a new method to calculate the consolidation coefficient of lignite seams, Wielkopolska region in central Poland

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Abstract Only one quantitative method is described in the literature to estimate the consolidation coefficient of lignite seams. More studies concentrate on the compaction of plant tissues, which explains why the obtained results are overestimated. Moreover, most studies do commonly not determine the consolidation of the whole peat bog but usually those of some of its elements only. We propose a new approach, which conceptually is fairly close to the Hager et al. (Fortschr Geol Rheinld Westf 29:319–352, 1981) method. Our method has been tested on an example of the first Middle-Polish Lignite Seam and the second Lusatian Lignite Seam from some Wielkopolska lignite deposits in central Poland. The consolidation coefficients, C_c, range between 2.34 and 2.56 for the second Lusatian Lignite Seam and between 1.80 and 2.14 for the first Middle-Polish Lignite Seam.

Keywords Wielkopolska region (Poland) · Miocene · Lignite seam · Peat bog · Consolidation coefficient

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Introduction

Consolidation is one of the most important processes in rock transformation, including the transition from peat to lignite to coal (Baldwin and Butler 1985; Nadon 1998; Sheldon and Retallack 2001). Consolidation plays a significant role in modern geohistory analysis (Van Hinte 1978; ten Veen and Kleinspehn 2000; Michon et al. 2003; Widera 2004; Widera et al. 2004) and sedimentological investigations (Herbert 1997; Tibert and Gibling 1999), and has significant geotechnical and hydrological implications (Guo et al. 2003; Price et al. 2005).

In general, the consolidation coefficient is described as the original thickness divided by the present-day thickness of a deposit. In our opinion, the term compaction coefficient is much more suitable for mineral sediments (Baldwin and Butler 1985; Sheldon and Retallack 2001).

In the case of peats and lignites, the compaction process means physical dewatering and compression of plant remains, which may be tested in the laboratory (Guo et al. 2003; Price et al. 2005). Very important changes of peat and lignite thickness are also caused by bio- and geo-chemical processes (Teichmüller 1982; Clymo 1983; Nurkowski 1984; England and Mackenzie 1989; Wiesner et al. 1989). Therefore, the term consolidation coefficient will be used below. In the present contribution, the consolidation coefficient of lignite seam is defined as the ratio between the peat bog thickness before burial and the present thickness of the resulting lignite seam (Widera 2002).

The literature on peat and lignite consolidation is both poor and unnecessarily complicated. In contrast, the literature on mineral-sediment compaction, as summarized by Baldwin and Butler (1985) and Sheldon and Retallack (2001), is extensive and much less complicated. Older methods, formulas and estimations of lignite and coal consolidation coefficients have been compiled by Ryer and Langer (1980). In fact, they have introduced the consolidation coefficient of coal, not of lignite. Its values range from 1.4 to 30.0, with an average of 7.0 (Ryer and Langer 1980). The consolidation coefficient calculated from dinosaur footprints at the top of coal has a value of 1.15 (Nadon 1998). He pointed out that the value of the consolidation coefficient is frequently overestimated in the works listed by Ryer and Langer (1980). The above values refer to coal and show a wide range. The consolidation coefficient for lignite is between 1.15 and 30.0 on the basis of coal examinations (Ryer and Langer 1980; Nadon 1998).

Several authors have estimated the consolidation coefficient of lignite by Harish and Hunger's method (in: Piwocki 1975). In practice, this coefficient has been calculated on the basis of tree-trunk deformations (Winston 1986). The compaction coefficient of trunks and branches during transition from peat to lignite has been found to range between 2.0 and 7.0 in the Eocene lignites of Canada (Kojima et al. 1998), and between 3.0 and 5.0 in the Miocene lignites of Poland (Piwocki 1975). In both examples, the average value is ~4.0. This method can determine only the compaction for peat. Unfortunately, it does not indicate the consolidation of the whole peat bog, which consists of more and less competent elements (Teichmüller 1982; Clymo 1983; Courel 1987; Kojima et al. 1998).

Thus, there is no method in the above-mentioned literature that reliably estimates the consolidation coefficient of lignite deposits as a whole. The various methods yield different results and do not answer the question of how thick the peat bog was before burial. In our opinion, the only attempt to solve this problem is the Hager et al. (1981) method. Unfortunately, this work, written in German with an English abstract, is not world-wide known. It is therefore a secondary objective of the present contribution to draw attention to the Hager et al. (1981) method on the occasion of its 25th anniversary of its publication.

Geological setting

In the Wielkopolska region (central Poland), Miocene lignites are exploited in open-cast mines in the vicinity of Konin and Turek (Fig. 1). A few lignite deposits have been documented on the basis of more than 7,000 boreholes. The largest lignite deposits occur in grabens that were active in the Palaeogene and/or Neogene (Widera 2004). These lignite seams stratigraphically belong to two seam horizons, i.e. the first Middle-Polish Lignite Seam and the second Lusatian Lignite Seam (Piwocki and Ziembińska-Tworzydło 1997). The last one is located in the Lubstów Graben only, and is excavated in the Lubstów open-cast mine (Fig. 2). It is the stratigraphical equivalent of the main lignite seam in the Lower Rhine Basin (Zagwijn and Hager 1987; Schäfer et al. 2005) and in the Lusatian Brown Coal District (Ahrens and Lotsch 1963; Lotsch et al. 1969; Standke et al. 1993). The first Middle-Polish Lignite Seam occurs—and is exploited—in the other open-cast mines of the Wielkopolska region. Four grabens in which the first Middle-Polish Lignite Seam or the second Lusatian Lignite Seam are present, are dealt with in the following. They are: the Kleczew, Adamów, Piaski and Lubstów Grabens (Fig. 1b).

The lithostratigraphy of these graben fills with their lignite seams is schematically shown in Fig. 2. The stratigraphic position of the various formations and members is presented within the framework of recent chronostratigraphic schemes (Steininger and Rögl 1983; Daniels et al. 1985; Steininger et al. 1987; Gradstein et al. 2004). The Palaeogene and/or Neogene deposits overlie a Mesozoic substratum. The Palaeogene deposits are known from the Lubstów Graben and partially from the Piaski and Adamów Grabens (Figs. 1b, 2). The Neogene lignite deposits—called Pątnów I–IV, respectively—are present in the Kleczew Graben only.

The age of the Palaeogene deposits reaches from uppermost Eocene to Early Oligocene (Piwocki and Ziembińska-Tworzydło 1997). Above the Early Oligocene deposits, a stratigraphical hiatus is present (Fig. 2). The unconformity on top of this hiatus represents a time interval of uplift and erosion in the Late Oligocene (Widera 2004). Then, in the Early Miocene, deposition of sands begun in the eastern Wielkopolska area. The Rawicz Formation is distinguished in the Lubstów Graben, where the second Lusatian Lignite Seam—regionally called the Lubstów Seam—is found in the upper part of sedimentary succession. This lignite seam is a significant part of the Ścinawa Formation. In other grabens, the first Middle-Polish Lignite Seam—regionally called the Konin Seam (Fig. 2) is present at the top of the Early Miocene sands. These sands belong to the Koźmin Formation, which interfingers laterally with sediments of the Rawicz, Ścinawa and Adamów/Pawłowice Formations and with the Middle-Polish Member in the Lubstów Graben. The age the Koźmin Formation ranges from Early Miocene to Middle Miocene (Widera 2004). The Middle-Polish Member, including

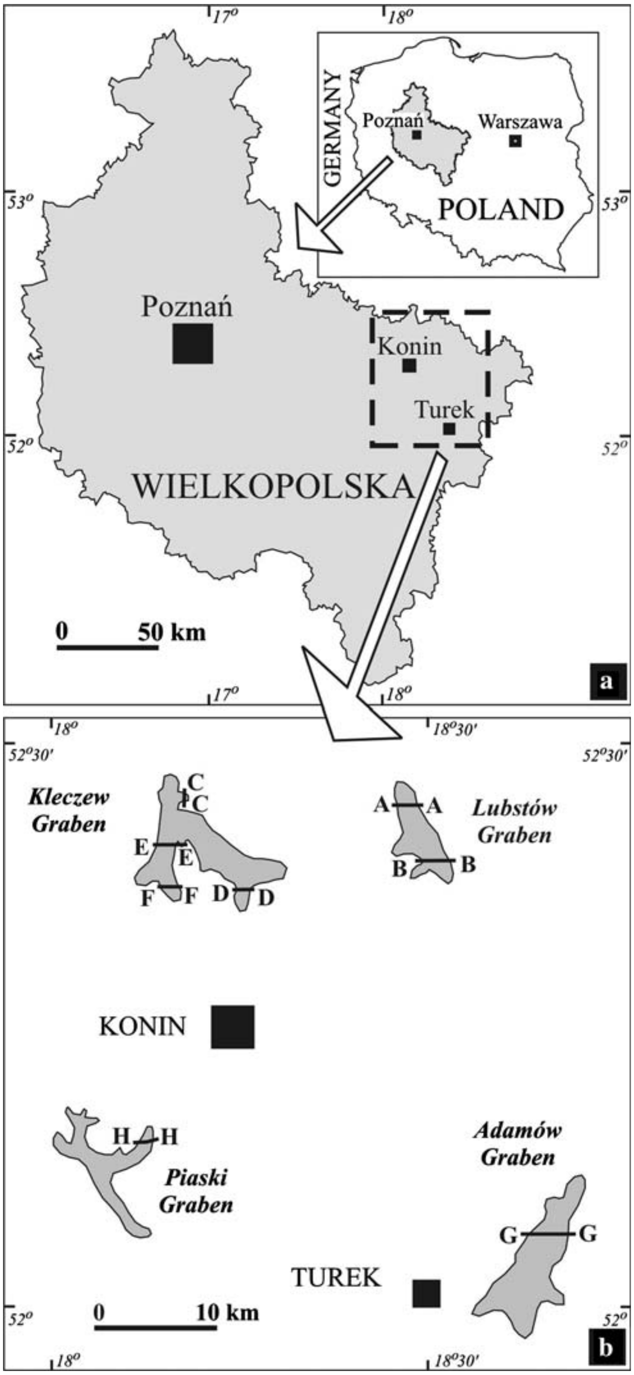

Fig. 1 Location map. **a** Location of the Wielkopolska region within Poland. **b** Tectonic grabens with location of the cross-sections (A–A to H–H) presented in Fig. 5

the lignite seam, forms part of the Poznań Formation with its clayey and silty deposits mainly known as the Wielkopolska Member (Piwocki and Ziembińska-Tworzydło 1997). On top of these sediments, belonging to different lithostratigraphic units, rests a Pleistocene and Holocene cover (Fig. 2).

Outline of the Hager et al.'s method

The Hager et al.'s (1981) method is based on the fact that the lignite seams in the Lower Rhine Basin are laterally accompanied by equally old clastic deposits. The mentioned authors compared two borehole profiles: one with mainly lignite and a second one with mainly mineral sediments (Fig. 3). The Lower Rhine Basin is an area where marine deposits, bearing glauconite and fauna, interfinger with fluvial and lacustrine sediments with lignites (Zagwijn and Hager 1987; Vinken 1988; Michon et al. 2003; Schäfer et al. 2005) so that correlation of the Miocene organic and clastic deposits is possible.

To obtain the consolidation coefficient of lignite, Hager et al. (1981) compared the boreholes, i.e. Straeten 1 and 49/71, located in the vicinity of Köln, Northwestern Germany. In the first borehole, 258.5 m of sands, clays and two relatively thin lignite beds were found. In the second borehole, 101.0 m of a continuous lignite seam—the Rhenish Main Seam—were encountered (Fig. 3). Excluding possible erosion and taking into consideration changes in porosity of sand, clay and lignite intercalations as a result of their own and the overburden's weight, Hager et al. (1981) estimated the original thickness of the Straeten 1 profile to have been 268.0 m. Perhaps because of their knowledge of the laterally correlatable deposits in the Lower Rhine Basin, they assumed that the initial thickness of the peat in the 49/71 borehole must have been the same as that of the sediments in the Straeten 1 borehole, i.e. 268.0 m (Fig. 3). On the basis of the present-day thickness of the lignite seam and the assumed original thickness of the peat, the consolidation coefficient of the lignite could be calculated. Thus, a value of 2.65 was obtained for both boreholes. Moreover, Hager et al. (1981) also compared a second pair of boreholes located in the same area and came to an estimated value of 3.45. It was thus concluded that the consolidation coefficient of the Rhenish Main Seam ranges from 2.65 to 3.45 (Hager et al. 1981).

The Hager et al.'s (1981) method has already been used by Kasiński (1984) for the Miocene lignite seams in western Poland. He made calculations for the second Lusatian Lignite Seam in the Krzywiń, Złoczew and Żytawa Grabens, where terrestrial and marine deposits interfinger laterally. These areas underwent short-term marine ingressions at the transition from Early to Middle Miocene (Ahrens and Lotsch 1963; Lotsch et al. 1969; Piwocki 1975; Vinken 1988; Standke et al. 1993; Piwocki and Ziembińska-Tworzydło 1997). Using the Hager et al.'s (1981) method, but without input data, Kasiński (1984) estimated the consolidation

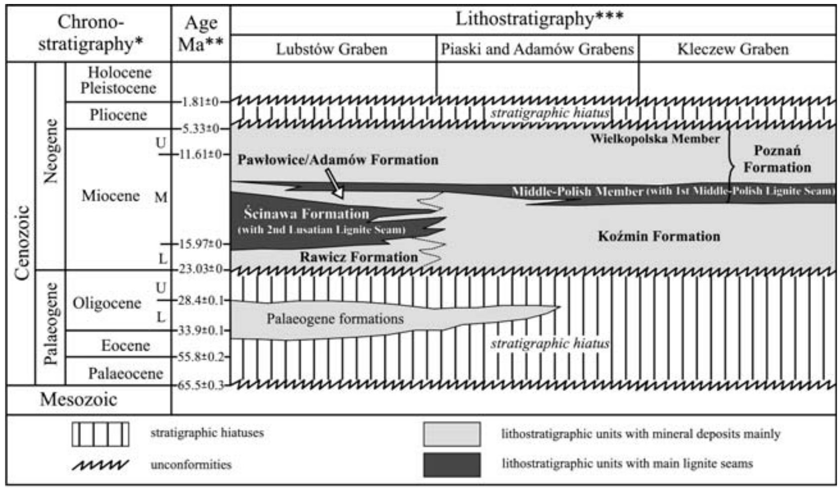

Fig. 2 Schematic stratigraphy of the investigated grabens in the eastern Wielkopolska area. *Chronostratigraphy according to Steininger and Rögl (1983), Daniels et al. (1985), and Steininger et al. (1987). **Age according to Gradstein et al. (2004). ***Lithostratigraphy according to Piwocki and Ziembińska-Tworzydło (1997) and Widera (2004)

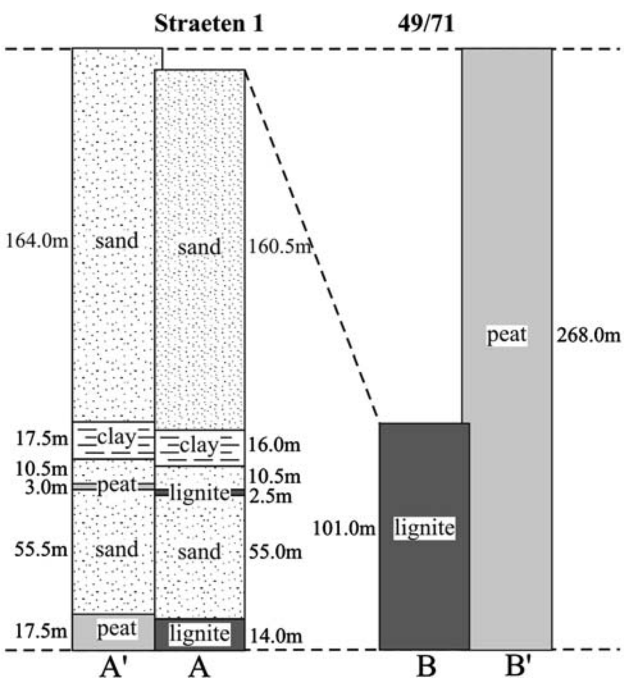

Fig. 3 Concept of the Hager et al.'s (1981) method applied to the Straeten 1 and 49/71 boreholes from the Lower Rhine Basin (slightly modified after Hager et al. 1981). **A, B** Present-day profiles of the two boreholes (i.e. after consolidation). **A′, B′** Original profiles of the two boreholes (i.e. before consolidation) as reconstructed by Hager et al. (1981)

coefficient of some Polish lignite seams as ranging from 1.7 to 2.9.

Method

Here, we present a new method to calculate the consolidation coefficient. It is conceptually close to the Hager et al.'s (1981) method. Unfortunately, Hager et al.'s (1981) method cannot be applied in its original form in the case of the lignite seams in our study area. The main reason is that the clastic deposits interfingering with the lignite seams are developed in fluvial and lacustrine facies in the eastern Wielkopolska region (Piwocki and Ziembińska-Tworzydło 1997; Widera 2002, 2004), so that no marine horizons are available for proper correlation of the mineral (non-marine) and the organic deposits (lignite seams) in the Lower Rhine Basin (Zagwijn and Hager 1987; Vinken 1988; Michon et al. 2003; Schäfer et al. 2005).

For the method presented here, we have taken into consideration our investigations of lignite seams in open-cast mines, in combination with the results obtained from studies of modern peat-forming environments (Bloom 1964; Clymo 1983; Long et al. 2006; and references therein). The water-table fluctuations and decomposition of organic matter during peat consolidation are very important for our study (Teichmüller 1982; Clymo 1983; Courel 1987; Kojima et al. 1998; Price et al. 2005; and references therein). Field observations indicate that the lowermost layers of the lignite seams are time-equivalent. Because the peat-bog surface was controlled by the position of the water table, the peat-bog surface before burial can be regarded as horizontal (Fig. 4a). This assumption is generally considered valid for Holocene (Bloom 1964; Clymo 1983; Schipper and McLeod 2002; Long et al. 2006) as well as for Palaeo-, Meso-, and older Cenozoic peat bogs (Ryer and Langer 1980; Hager et al. 1981; Kasiński 1984; Courel 1987; Herbert 1997; Kojima et al. 1998; Tibert and Gibling 1999; Widera 2002). The present-day lignite-seam architecture is well known from boreholes data (Fig. 4b).

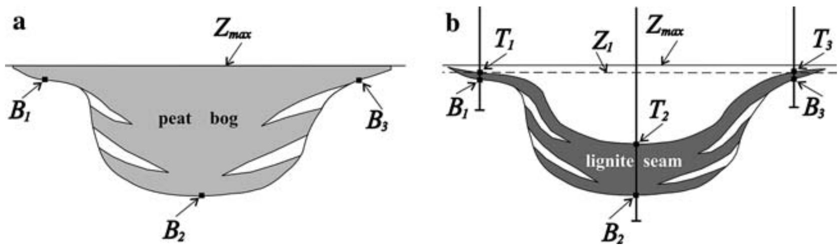

Fig. 4 Conceptual model for the calculations of the consolidation coefficient according to the method presented in the present contribution. **a** Scheme of the initial peat-bog architecture (i.e. before consolidation); **b** scheme of the present-day lignite-seam architecture (i.e. after consolidation). For further explanations, see in text

The above data allow calculation of the consolidation coefficient, and the calculations yield geologically realistic results, although only under three conditions.

- Firstly, postsedimentary erosion of the surface of the peat bog and the lignite seam is absent. Profiles of boreholes with clayey and silty deposits at the top of lignite seams may therefore be used for the calculations, but profiles where the lignite seams are overlain by sands or gravels and most of all by the Pleistocene glaciogenic deposits should not be used as proper input data.
- Secondly, postsedimentary tectonic and/or glaciotectonic deformations are excluded. Major postsedimentary tectonic and/or glaciotectonic deformations are relatively easy to detect. Unfortunately, it is impossible to take all minor deformations into consideration.
- Thirdly, mineral intercalations in the lignite seam are absent. The physical properties of lignite in different parts of the seam, e.g. with or without mineral intercalations, are approximately constant (Piwocki 1975; Hager et al. 1981; Nurkowski 1984; Kojima et al. 1998). Although these properties of peat tend to change gradually from bottom to top, they have no significant influence on the obtained results (Bloom 1964; Clymo 1983; Schipper and McLeod 2002; Guo et al. 2003; Price et al. 2005). In contrast, even few decimeters of clastic overburden increases the compaction of the underlying peats and creates an accommodation space for new organic sedimentation, which complicates the calculations (Herbert 1997; Tibert and Gibling 1999; Schipper and McLeod 2002; Widera 2002; Long et al. 2006). In the case of profiles with mineral intercalations in the lignite seam, the consolidation coefficient of the lignite will always be overestimated. The third observation therefore should be taken into consideration.

The applicability of the method proposed in the following will be shown on the basis of cross-sections constructed from hypothetical boreholes data. The first borehole contains a thin lignite seam, whereas the second borehole comprises a thick lignite (Fig. 4b). As mentioned above, the consolidation coefficient (C_c) of the peat from which the lignite seam was derived, is the ratio between the original peat-bog thickness before burial and the present-day thickness of the lignite seam. The following generalized equation can be applied to both selected boreholes (Fig. 4b):

$$C_c = (Z_{max} - B_2)/(T_2 - B_2), \tag{1}$$

where Z_{max} is the top level of the peat bog before burial, B_2 is the present-day level of the thick lignite seam, and T_2 is the top level of the thick lignite seam.

The primary peat-bog thickness before burial should be estimated. The top level of the peat bog before burial (Z_{max}) is calculated from the equation:

$$Z_1 = \frac{1}{2}(T_1 + T_3), \tag{2}$$

where Z_1 is the mean level of the lignite seam between boreholes with a thin lignite seam, T_1 is the top level of the thin lignite seam in the first borehole, and T_3 is the top level of the thin lignite seam in the second borehole (Fig. 4b). Then, using Z_1, an approximated consolidation coefficient (C_{c1}) may be estimated:

$$C_{c1} = (Z_1 - B_2)/(T_2 - B_2), \tag{3}$$

Combining Eq. 3 with Eq. 2, a first approximation of the consolidation coefficient is obtained:

$$C_{c1} = \left(\frac{1}{2}T_1 + \frac{1}{2}T_3 - B_2\right)/(T_2 - B_2). \tag{4}$$

Now, taking the C_{c1} value in the boreholes with the thin lignite seams into consideration, Z_{max} is given by the equation:

$$Z_{max} = \frac{1}{2}\{[B_1 + (T_1 - B_1)C_{c1}] + [B_3 + (T_3 - B_3)C_{c1}]\}, \tag{5}$$

where B_1 is the base level of the thin lignite seam in the first borehole, and B_3 is the base level of the thin lignite seam in the second borehole (Fig. 4b). This equation can also be written as:

$$Z_{\max} = \frac{1}{2}[(B_1 + T_1C_{c1} - B_1C_{c1}) + (B_3 + T_3C_{c1} - B_3C_{c1})]. \tag{6}$$

Now, the consolidation coefficient of the lignite seam can be calculated. In a simplified form, the final equation has a parameter C_{c1}, which should be calculated with Eq. 4. C_{c1} should be determined first, and then C_c. Combining Eq. 1 with Eq. 6 results in the final equation:

$$C_c = \left\{\frac{1}{2}[(B_1 + T_1C_{c1} - B_1C_{c1}) + (B_3 + T_3C_{c1} - B_3C_{c1})] - B_2\right\} / \{T_2 - B_2\}. \tag{7}$$

Results and discussion

On the basis of Eqs. 4 and 7, the consolidation coefficient of some lignite seams in the Wielkopolska lignite deposits can be estimated. We have chosen six cross-sections representing six lignite deposits located in four tectonic grabens (Fig. 1). The following lignite deposits have been selected: Lubstów (in the Lubstów Graben), Pątnów I, Pątnów III and Pątnów IV (Kleczew Graben), Adamów (Adamów Graben) and Piaski (Piaski Graben). The cross-sections and boreholes for this comparative study have been selected very carefully. The architecture of the analyzed lignite seams is presented in simplified cross-sections (Fig. 5). Data derived from the borehole profiles and used for the calculations are included in Table 1.

We have obtained values of 2.34 and 2.56 for the consolidation coefficient, C_c, for the two boreholes 156/102 and 24/26 that are located along two different cross-sections (Fig. 5a, b). These values regard the lignite consolidation of the second Lusatian Lignite Seam in the Lubstów Graben (Fig. 2 and Table 1). It should be mentioned here that such calculations cannot be done for the deepest, SE part of the Lubstów Graben where the thickness of the Lusatian lignite seam amounts to 86.2 m. This area underwent an uplift of about 100 m after sedimentation of the peat during the post-Moldowian tectonic phase (Widera 2004).

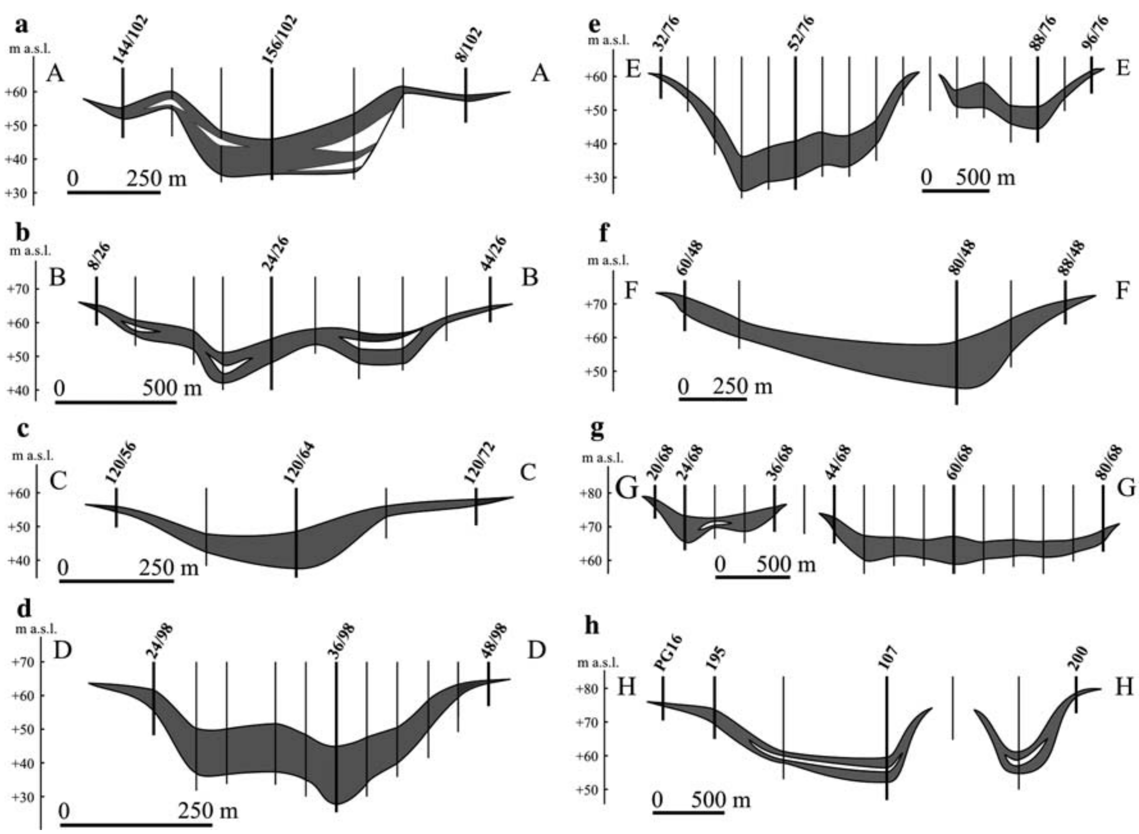

Fig. 5 Lignite-seam architecture along selected cross-sections with positions of the boreholes used for the calculations of the consolidation coefficient. A–A and B–B: Lubstów Graben; C–C, D–D, E–E and F–F: Kleczew Graben; G–G: Adamów Graben; H–H: Piaski Graben. For locations see Fig. 1b

Table 1 Parameters of the lignite seams in boreholes and results of the consolidation-coefficient calculations

Cross-section (Fig. 1b)	Location lignite deposit (graben) lignite seam (Fig. 1b)	Borehole T_1–B_1 [m a.s.l.]	Borehole T_2–B_2 [m a.s.l.]	Borehole T_3–B_3 [m a.s.l.]	Z_1 (2) [m a.s.l.]	C_{c1} (3)	Z_{max} (6) [m a.s.l.]	C_c (1)
A–A	Lubstów I lignite deposit (Lubstów Graben) Second Lusatian seam	144/102 55.4–51.8	156/102 47.0/37.6	8/102 58.7/56.5	57.05	2.03	60.10	2.34
B–B	Lubstów I lignite deposit (Lubstów Graben) Second Lusatian seam	8/26 65.6–64.3	24/26 55.1/47.9	44/26 64.4/63.8	65.00	2.38	66.32	2.56
C–C	Pątnów IV lignite deposit (Kleczew Graben) First Middle-Polish seam	120/56 55.9–53.8	120/64 48.9/38.5	120/72 58.3/56.6	57.1	1.79	58.90	1.96
D–D	Pątnów I lignite deposit (Kleczew Graben) First Middle-Polish seam	24/98 62.3–55.9	36/98 45.7/26.7	46/98 65.8/65.4	64.05	1.97	67.35	2.14
E–E	Pątnów III lignite deposit (Kleczew Graben) First Middle-Polish seam	32/76 60.6–59.4	52/76 41.2–29.9	96/76 61.4–60.4	61.00	2.75	62.93	2.92
		32/76 60.6–59.4	88/76 51.1–44.1	96/76 61.4–60.4	61.00	2.41	62.56	2.63
F–F	Pątnów III lignite deposit (Kleczew Graben) First Middle-Polish seam	60/48 71.6–67.6	80/48 59.6–45.4	88/48 70.8–68.0	71.20	1.87	74.16	2.08
G–G	Adamów lignite deposit (Adamów Graben) First Middle-Polish seam	20/68 78.2–76.0	24/68 73.0–66.0	36/68 76.4–74.2	77.30	1.61	78.62	1.80
		44/68 72.5–67.9	60/68 66.6/59.6	80/68 69.0–65.4	70.75	1.59	73.17	1.94
H–H	Piaski lignite deposit (Piaski Graben) First Middle-Polish seam	PG16 75.7–75.2	107 59.3–51.8	200 78.4–78.0	77.05	3,37	78,12	3,51
		PG16 75.7–75.2	195 72.5–69.6	PG16 75.7–75.2	75.70	2.10	76.75	2.46

For explanations see the text; for locations of the cross-sections see Fig. 1b

In contrast, there is no significant evidence for postsedimentary tectonic activity in the northern- and southernmost parts of the Lubstów Graben. Therefore, the results may, however, be considered as methodologically correct and geologically realistic. The consolidation coefficient, C_c, of the second Lusatian Lignite Seam in the Lubstów Graben ranges from 2.34 to 2.56, these values are within the wide range given by Hager et al. (1981), Kasiński (1984) and Widera (2002) for stratigraphically equivalent lignite seams in Germany and Poland.

The first Middle-Polish Lignite Seam yielded more results than the second Lusatian Lignite Seam. This is mainly due to the wide extent of this lignite seam in the eastern Wielkopolska area concerning in all lignite deposits of the Konin–Turek region (Fig. 2). The consolidation coefficient was found to range from 1.80 to 3.51 (Table 1). The majority of the values obtained are accurate, but some of them are overestimations. The suspicious results were calculated for cross-sections E–E and H–H (Fig. 5e, h). In the first example, the overestimated of C_c (ranging between 2.63 and 2.92) is probably caused by postsedimentary tectonic movements of the axial zone of the western parts of the Kleczew Graben, i.e. the Pątnów III lignite area (Fig. 1b, Table 1). In the second example, the results of the calculations for cross-section H–H, are more complex. For borehole 107, which comprises a 0.9 m mineral intercalation in the lignite seam, the value of the C_c was calculated as 3.51, whereas for borehole 195, which comprises a continuous lignite seam, the C_c value was calculated as 2.46 (Table 1). Both results include postdepositional tectonics and/or the presence of mineral intercalations, and therefore each precission. Taking into consideration both the limitations of the method presented and the regional geological context, the consolidation coefficient, C_c, of the first Middle-Polish Lignite Seam may be considered to range between 1.80 and 2.14 for the Wielkopolska lignite deposits that have been investigated (Table 1).

Conclusions

The method presented here has been established with the objective to determine the consolidation process of peat during its transformation into lignite quantitatively. Most earlier studies were based on estimates of the compaction of individual plant remains rather than the whole peat bog. Moreover, some of these investigations described the consolidation of the peat bog and lignite seam qualitatively only. In our opinion, the first significant attempt to quantify lignite consolidation was made by Hager et al. (1981). Their method could, however, not be applied to the lignite seams in eastern Wielkopolska where, in contrast to the Lower Rhine Basin, clastic and organic deposits of similar age are absent.

The new method presented is based on the analysis of boreholes with thick central and thin marginal lignite seams within one peat-bog basin. Only few, simple equations are required to estimate the primary height of the peat-bog surface before burial. The thickness of the present-day lignite in the boreholes is, obviously, known. Then, the consolidation coefficient can be easily estimated. In order to obtain geologically correct results, the boreholes used for the input data must be selected carefully. Boreholes with the following phenomena are to be excluded: postdepositional erosion, postdepositional tectonics and/or glaciotectonics, the presence of mineral intercalations. Further, we suggest to perform the calculations by applying the equations in the following order: 2, 3, 6 and 1 (Table 1).

The consolidation coefficients, C_c, of the second Lusatian Lignite Seam and the first Middle-Polish Lignite Seam in the eastern Wielkopolska area have thus been calculated. The values of 2.34–2.56 for the former and of 1.80–2.14 for the latter have been obtained. These results fit well in the range of the values for C_c presented in earlier literature (e.g. Hager et al. 1981; Kasiński 1984).

Our method has some advantages and disadvantages. It is mathematically quite easy to estimate the original thickness of the peat bog. The effects of postdepositional tectonic displacements of the resulting lignite seam can be estimated. Unfortunately, this method needs uncommonly accurate drilling documentation of the lignite deposits. Moreover, statistically reliable results require data from a number of boreholes in the investigated lignite seam. On the other hand, the consolidation coefficient, C_c, obtained is not valid for the whole lignite seam, and for the selected boreholes only.

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